INTRODUCTION AND PURPOSE

By the time it is known that an explosive radiation incident has occurred, there will be numerous casualties, all of the radioactive material will have been released, and the plume growth will be progressing. Under those conditions, there will be no time to evaluate possible countermeasures. Therefore, a pre-planned system of response is critical to the successful management of any event involving radiation.

The purpose of this document is to offer guidance to planners, first responders, and senior decision makers in developing strategies for protective actions and operational procedures immediately following an explosive radiation event that involves the release, explosive aerosolization, and dispersion of radioactive material.

The document includes practical guidance for the user community, i.e., planners, police, firefighters, hazardous materials technicians, and emergency medical technicians. It also is pertinent to Emergency Operations Center (EOC) managers who must recommend protective actions to senior decision makers in our communities.

PRINCIPAL AREAS OF CONCERN

1. Define and optimize the size of the initial evacuation zones, and recommend evacuation strategies for the hot, warm, and cold zones, based on the most recent scientific evidence
2. Provide for the protection of first responders
3. Recommend practical strategies for sheltering and evacuation
4. Provide practical information regarding the triage of large numbers of potentially contaminated evacuees

RECOMMENDED RESPONSE

A. Establish Ground Zero

1. The area impacted during the emergency phase by an explosive Radiation Dispersion Device (RDD), as well as lesser affected areas that have levels of contamination that meet or exceed the criteria of 10 –50 mSv for evacuation (U.S. EPA 1992), can be assumed to be bounded within a 600 foot radius (Harper et al. 2006) and might be considerably smaller, depending on the amount of radioactivity in the weapon and the kinetics of the explosive. Accordingly:
   a. If there is no knowledge of the size of the initial radiological source, or if it is known that the device contained a very large radiological source (greater than 370 Tbq or 10,000 Ci), establishing a hot zone boundary at 600 feet in all directions from ground zero is assumed to be a reasonable and safe precaution. This boundary definition is consistent for both alpha and beta-gamma emitters.
b. Control access to the hot zone to limit the number of non-contaminated persons entering the most contaminated area  
c. Define the outer boundary of the hot zone at 10 mSv hr\(^{-1}\) to establish the point where emergency personnel can stay, unrestricted, for 4 –5 hours without exceeding 50 mSv of external exposure  
d. Confirm the outer boundary of the hot zone when the actual 10 mSv hr\(^{-1}\) line is determined from instrument readings. In most cases, this will be much closer to the source than 600 feet  
e. If it is known that the source is smaller than 370 Tbq (10,000 Ci), establish the initial hot zone boundary at 600 feet without waiting for measurements from instrumentation  
f. Do not decide anything based on the perceived wind direction, especially in an urban setting where the wind field can be very complex  
g. Once the hot zone is defined, establish the outer boundary of the warm zone where the radiation level is in the range of 0.01– 0.1 mSv hr\(^{-1}\). Use of this range to define this boundary gives first responders flexibility to set up the outer boundary of the warm zone at the most pragmatic locations, rather than being tied to an explicit exposure rate, i.e., 0.02 mSv hr\(^{-1}\)  
h. The cold zone is defined outside of the outer boundary of the warm zone such that occupancy time is unrestricted for the first responders  

2. Establish the command post in the cold zone upwind from ground zero, or where the radiation or contamination level is less than 0.01– 0.1 mSv hr\(^{-1}\), or at 1,000 counts min\(^{-1}\) at 3 cm above the ground on a pancake type Geiger-Meuller type probe for a beta-gamma emitter, or 10 counts min\(^{-1}\) at 1–2 cm above the ground with a 100 cm\(^{2}\) alpha probe.  
a. If geographical circumstances do not permit this from a practical standpoint, the alternative recommendation is to choose the location based on a level of ground contamination that limits the impact to personnel and equipment  
b. This selected place might have dose rates up to 0.2 mSv hr\(^{-1}\), or 10,000 counts min\(^{-1}\) at 3 cm above the ground on a pancake-type Geiger-Mueller-type probe for a beta-gamma emitter, or 100 counts min\(^{-1}\) at 1–2 cm above the ground with a 100 cm\(^{2}\) alpha probe  

3. As soon as possible, ensure that first responders promptly measure and record exposure rates to locate, map and mark the hot, warm and cold zones  
a. This is the most critical piece of information that the local EOC will need to begin to assess the order of magnitude of the overall event, and will assist first responders to control their own exposure in the first critical hours  

4. Expect that the Evacuation Zones will likely require redefinition following the arrival of federal resources, probably in a 12–24 hour timeframe as indicated in the National Response Plan (U.S. DHS 2004)  

5. Expect a mass self-evacuation from the affected area, including the hot zone  
a. Designate evacuation routes and exits/triage/decontamination points to quickly channel evacuees safely away from the hot zone  
b. Pre-position radiological monitors at exits  
c. Assure that exits are located in relatively cold zones (i.e., < 2x background)
6. While medically significant levels of contamination are not expected among uninjured contaminated persons, some hot zone evacuees or contaminated victims may need prompt decontamination and/or medical intervention due to potential acute effects from hot skin contamination, or to mitigate an inhalation exposure

B. Decontamination Strategies

1. Triage and decontamination strategies should be developed separately from those used for chemical and biological agents
   a. Expect that the exposed victims’ clothes or bodies will not be dangerously contaminated, nor will they have inhaled enough radioactivity to cause acute health effects
   b. This is in contrast to chemical or biological agents, where the material still present on the victims could be immediately dangerous to them or to others with whom they will subsequently have contact
2. Do not plan to perform mass decontamination if the number of evacuees is very large
   a. Allow victims to go home. Advise them to remove and bag their external garments before entering a dwelling. Few, if any, particles will penetrate outside clothing, especially if it is not summertime. Garments and jackets serve as effective protection from radioactive particulates
   b. Advise those who believe they were contaminated to take a shower with warm water and mild soap, gently washing the exposed skin as practical (head, hair, hands), and to not use hair conditioner, which may fix the contamination on the skin
   c. Survey the bagged clothing after the emergency phase is over
3. Do not plan to decontaminate motor vehicles in the emergency phase
4. Do not waste effort trying to contain contaminated wash water (U.S. EPA 1992)

C. Triage Strategies

1. First, separate those people who need medical consideration from those who do not
2. Assume that a person is not likely to have received a significant dose from inhalation unless presenting with gross external contamination at triage
3. Separate from all others those persons with upper body contamination, particularly of the shoulder, head, and hair. People with significant upper body contamination may require evaluation for follow-up medical treatment because they may have inhaled excessive amounts of radioactive material
4. Assume that individuals with contamination only on colder portions of the body crossed the contaminated zone, but were not exposed to the passing plume, and did not inhale hot airborne radioactivity in excessive concentrations

D. Personal Protective Equipment for First Responders

1. Because the initial plume will pass beyond the hot zone in 10–15 minutes, most first responders will not be exposed to hot airborne concentrations of particulates
because they will arrive after it has passed, or first will encounter the plume downstream, when concentrations have become diluted.

2. Therefore, because the remaining levels of airborne radioactivity, along with any additional contribution from re-suspension, will be relatively cold, the PPE requirements, as a minimum, are as follows:

1. Uniform
2. Goggles
3. Gloves of any type
4. Half-face air purifying respirator (APR) (most responders typically use a full-face APR that affords more protection)

E. Improvised Respiratory Protection in the Hot Zone

Improvised respiratory protection is recommended for use by the public to reduce inhalation during the approximately 10 to 15 minutes of the plume’s passage. For improvised respiratory protection, the following procedure is recommended:

1. Cover the mouth and nose with a dry cloth or handkerchief (NCRP 2001):
   
a. Note: wet material could actually enhance the amount of inhaled particles. For example, cesium chloride is water-soluble, and so a wet cloth could concentrate the radioactivity, as well cause labored breathing

2. Remove the protection 30 minutes after detonation

F. Sheltering Guidelines

Sheltering is not a critical countermeasure for an explosive scenario anywhere, although it can reduce exposure if located away from ground zero. Sheltering indoors during the passage of the plume can result in reduced exposure values (concentrations inside the building might be as low as 5% of external concentrations).

Note that sheltering beyond the time of proximity to the plume can result in additional rather than reduced exposure. The airborne concentration inside the buildings may become higher than the outdoor concentration due to the intake of radioactive material from the passing plume by a building’s ventilation system. Thus, while the outdoor concentrations may have significantly decreased, higher levels of particulates could remain inside the building.

The prompt shutdown or isolation of the air intake to a large urban building for 60 minutes post-detonation likely would mitigate the impact on the occupants. The efficiency of the filters in a large ventilation system can be significant, removing up to 90% of particulate material, depending on the particle size, the condition of the filter, and its design (U.S. DHHS 2003). However, as buildings are normally not equipped with radiation detectors, and most buildings do not have the ability to shut down an entire ventilation system with the “push of a button”, it is unlikely that these procedures could be accomplished in a timely manner.
SOURCE **
In order to reflect current research on radiation emissions and its impact on preparedness planning, this document is adapted in part from:

Emergency Response Guidance for the First 48 Hours after the Outdoor Detonation of an Explosive Radiological Dispersal Device
Stephen V. Musolino and Frederick T. Harper
Health Physics April 2006, Volume 90, Number 4

ALGORITHM FOR RESPONSE TO A RADIATION EVENT

1st responders establish Incident Command, notify 911 Dispatch
911 Dispatch notifies Emergency Operations Center
Incident Command or Emergency Operations Center requests CREPC activation of RED Plan
RED Plan RCC with ESF’s 2, 4, 5, 6, 8, 11, 13, 19
RCC notifies Region 3 Coordinator and NDMS
Incident Command begins monitoring to establish zones, determines need to evacuate